PB-239 550

# BIG EAU PLEINE RESERVOIR, MARATHON COUNTY, WISCONSIN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Wisconsin National Guard
Wisconsin Department of Natural Resources

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| eutrophication<br>lakes<br>nutrients<br>phosphorus<br>nitrogen<br>loading | | 05B<br>05C |

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REPORT

ON

# BIG EAU PLEINE RESERVOIR

MARATHON COUNTY

WISCONSIN

EPA REGION V

WORKING PAPER No. 33

WITH THE COOPERATION OF THE

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

AND THE

WISCONSIN NATIONAL GUARD

NOVEMBER, 1974

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# FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

## OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

## ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

## LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conduct of the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

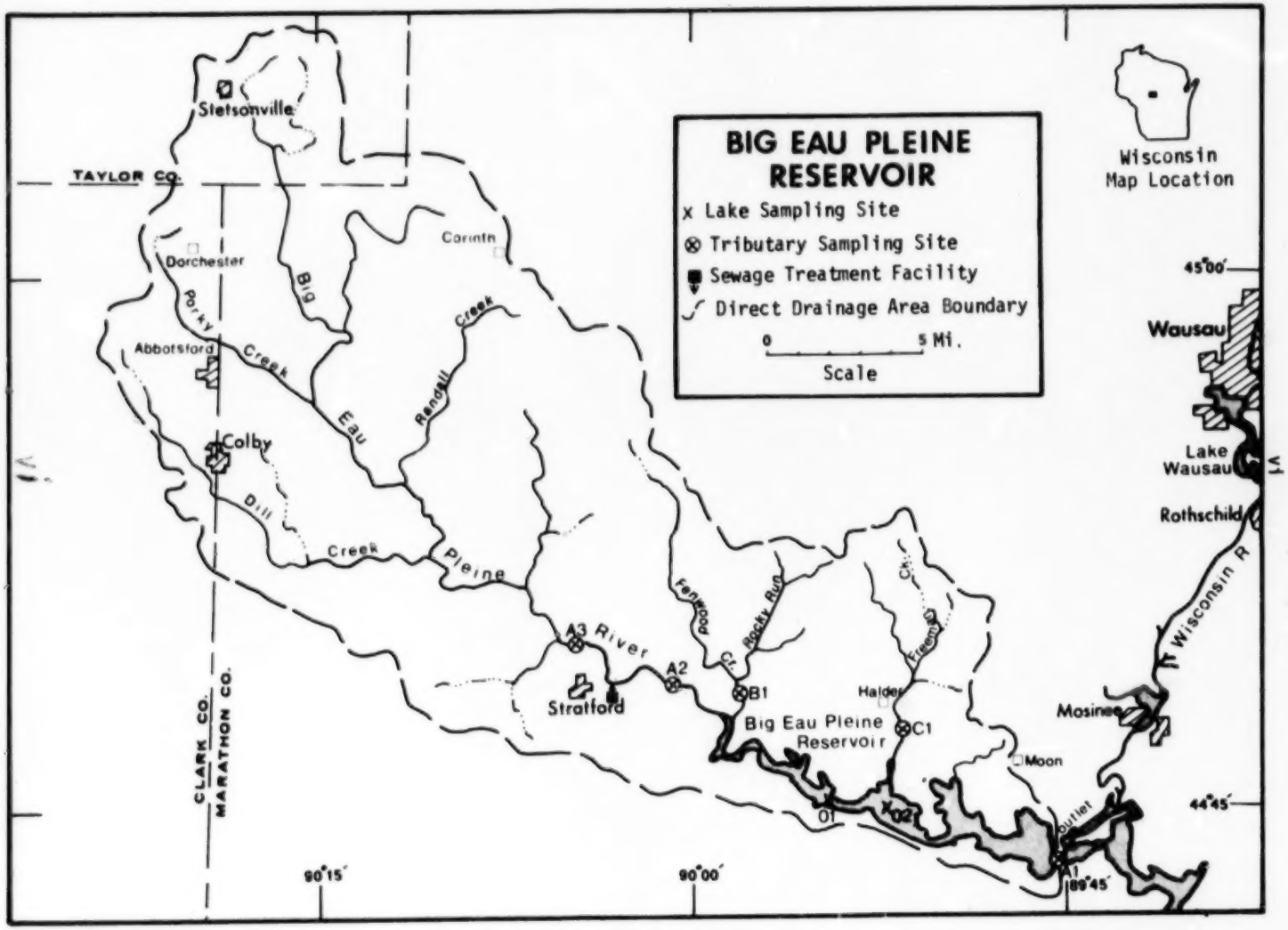
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

| LAKE NAME | COUNTY |
|---|---|
| Altoona | Eau Claire |
| Beaver Dam | Barron |
| Beaver Dam | Dodge |
| Big Eau Pleine | Marathon |
| Browns | Racine |
| Butte des Morts | Winnebago |
| Butternut | Price, Ashland |
| Castle Rock Flowage | Juneau |
| Como | Walworth |
| Crystal | Vilas |
| Delavan | Walworth |
| Eau Claire | Eau Claire |
| Geneva | Walworth |
| Grand | Green Lake |
| Green | Green Lake |
| Kegonsa | Dane |
| Koshkonong | Jefferson, Rock, Dane |
| Lac La Belle | Waukesha |
| Middle | Walworth |
| Nagawicka | Waukesha |
| Oconomowoc | Waukesha |
| Okauchee | Waukesha |
| Petenwell Flowage | Juneau |
| Pewaukee | Waukesha |
| Pigeon | Waupaca |
| Pine | Waukesha |
| Poygan | Winnebago, Waushara |
| Rock | Jefferson |
| Rome Pond | Jefferson, Waukesha |
| Round | Waupaca |
| Shawano | Shawano |

| LAKE NAME | COUNTY |
|---|---|
| Sinnissippi | Dodge |
| Swan | Columbia |
| Tainter | Dunn |
| Tichigan | Racine |
| Townline | Oneida |
| Trout | Vilas |
| Wapogassett | Polk |
| Wausau | Marathon |
| Willow | Oneida |
| Winnebago | Winnebago, Fond Du Lac, Calumet |
| Wisconsin | Columbia |
| Wissota | Chippewa |
| Yellow | Burnett |


BIG EAU PLEINE RESERVOIR
x Lake Sampling Site
⊗ Tributary Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 5 Mi.
Scale
Wisconsin Map Location
Stetsonville
TAYLOR CO.
Dorchester
Corinth
Porky Creek
Big Eau Pleine Creek
Abbotsford
Colby
Dill Creek
Rendall
Pleine
A3 River
A2
Stratford
Fenwood Ck.
Rocky Run
B1
Big Eau Pleine Reservoir
C1
Halder
Freeman Ck.
Moon
Mosinee
Wausau
Lake Wausau
Rothschild
Wisconsin R
CLARK CO.
MARATHON CO.
O1
X02
Outlet
45°00'
44°45'
90°15'
90°00'
89°45'

BIG EAU PLEINE RESERVOIR

STORET NO. 5565

# I. CONCLUSIONS

## A. Trophic Condition:

Survey data and the records of others indicate the Big Eau Pleine Reservoir is eutrophic.

## B. Rate-Limiting Nutrient:

The results of the algal assay indicate borderline nitrogen limitation. However, the Reservoir data indicate phosphorus limitation at station 1 on all sampling dates, while station 2 was phosphorus limited only in June and nitrogen limited in August and November.

## C. Nutrient Controllability:

1. Point sources--During the sampling year, the Big Eau Pleine Reservoir received a phosphorus load at a rate over twice that proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 15). Of this load, it is estimated that the Village of Stratford contributed less than 3%, and it is concluded that phosphorus control at this source alone would not result in a significant improvement in the trophic condition of the reservoir.

2. Non-point sources--The phosphorus export of the Big Eau Pleine River during the sampling year was more than twice that of Fenwood Creek and nearly six times that of Freeman Creek (see

page 15). If it is reasonable to assume that the phosphorus export of Fenwood Creek, not known to be impacted by point sources, represents typical areal or non-point source contributions of the drainage, then it appears that municipal and possibly industrial point sources tributary to the Big Eau Pleine River, but not included in the Survey, were contributing significant amounts of phosphorus during the sampling year.

## II. INTRODUCTION

The Big Eau Pleine Reservoir was created by impoundment of the Big Eau Pleine River by the Wisconsin Valley Improvement Company in 1937 (Martin and Hanson, 1966). The primary use of the reservoir is flow augmentation for the hydroelectric plant downstream on Lake DuBay.

Recreational uses of the reservoir include swimming, boating, and fishing. Game fish said to be present are muskellunge, northern pike, walleyes, largemouth bass, and panfish (Anonymous, 1972).

Though much of land around the reservoir is owned and controlled by the Wisconsin Valley Improvement Company, there are privately owned cottages and permanent homes on the shoreline, and public access is provided (Gall, 1972).

## III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

### A. Lake Morphometry*:

1. Surface area: 6,831 acres.
2. Mean depth: 15.6 feet.
3. Maximum depth: 46 feet.
4. Volume: 106,602 acre/feet.
5. Mean hydraulic retention time: 158 days.

### B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

| Name | Drainage area† | Mean flow† |
|---|---|---|
| Big Eau Pleine River | 250.0 $mi^2$ | 263.4 cfs |
| Fenwood Creek | 37.0 $mi^2$ | 24.7 cfs |
| Freeman Creek | 26.5 $mi^2$ | 17.4 cfs |
| Minor tributaries & immediate drainage - | 40.8 $mi^2$ | 35.5 cfs |
| Totals | 354.3 $mi^2$ | 341.0 cfs |

2. Outlet -

| | | |
|---|---|---|
| Big Eau Pleine River | 365.0 $mi^{2}$†† | 341.0 cfs |

### C. Precipitation†††:

1. Year of sampling: 48.1 inches.
2. Mean annual: 31.3 inches.

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* Dept. of Natural Resources lake survey map (1969).
† Drainage areas are accurate within ±0.5%; mean daily flows are accurate within ±40%; mean monthly flows are accurate within ±35%; and normalized monthly flows are accurate within ±35%.
†† Includes area of lake.
†††See Working Paper No. 1, "Survey Methods".

## IV. LAKE WATER QUALITY SUMMARY

The Big Eau Pleine Reservoir was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 36 feet at station 1 and 20 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

| Parameter | Minimum | Mean | Median | Maximum |
|---|---|---|---|---|
| | | FALL VALUES (11/08/72) | | |
| Temperature (Cent.) | 4.8 | 5.0 | 5.2 | 5.2 |
| Dissolved oxygen (mg/l) | 10.9 | 11.3 | 11.2 | 11.6 |
| Conductivity (μmhos) | 95 | 107 | 98 | 130 |
| pH (units) | 7.2 | 7.3 | 7.3 | 7.3 |
| Alkalinity (mg/l) | 16 | 19 | 18 | 25 |
| Total P (mg/l) | 0.068 | 0.084 | 0.079 | 0.107 |
| Dissolved P (mg/l) | 0.030 | 0.048 | 0.036 | 0.071 |
| $NO_2$ + $NO_3$ (mg/l) | 0.440 | 0.507 | 0.450 | 0.620 |
| Ammonia (mg/l) | 0.120 | 0.149 | 0.145 | 0.180 |
| | | ALL VALUES | | |
| Secchi disc (inches) | 22 | 32 | 35 | 41 |

B. Biological characteristics:

1. Phytoplankton -

| Sampling Date | Dominant Genera | | Number per ml |
|---|---|---|---|
| 06/23/72 | 1. | Anabaena | 3,996 |
| | 2. | Melosira | 1,248 |
| | 3. | Dinobryon | 145 |
| | 4. | Cryptomonas | 127 |
| | 5. | Stephanodiscus | 108 |
| | | Other genera | 488 |
| | | Total | 6,112 |
| 08/24/72 | 1. | Anabaena | 1,838 |
| | 2. | Oscillatoria | 108 |
| | 3. | Cryptomonas | 87 |
| | 4. | Stephanodiscus | 72 |
| | 5. | Gloeocapsa | 36 |
| | | Other genera | 80 |
| | | Total | 2,221 |
| 11/08/72 | 1. | Melosira | 1,582 |
| | 2. | Flagellates | 1,017 |
| | 3. | Synedra | 546 |
| | 4. | Cyclotella | 245 |
| | 5. | Anabaena | 151 |
| | | Other genera | 1,242 |
| | | Total | 4,783 |

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

| Sampling Date | Station Number | Chlorophyll a (µg/l) |
|---|---|---|
| 06/23/72 | 01 | 70.3 |
| | 02 | 39.9 |
| 08/24/72 | 01 | 26.6 |
| | 02 | 8.8 |
| 11/08/72 | 01 | 48.9 |
| | 02 | 18.3 |

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

| Spike (mg/l) | Ortho P Conc. (mg/l) | Inorganic N Conc. (mg/l) | Maximum yield (mg/l-dry wt.) |
|---|---|---|---|
| Control | 0.050 | 0.650 | 15.4 |
| 0.006 P | 0.056 | 0.650 | 15.8 |
| 0.012 P | 0.062 | 0.650 | 16.7 |
| 0.024 P | 0.074 | 0.650 | 15.7 |
| 0.060 P | 0.110 | 0.650 | 16.0 |
| 0.060 P + 10.0 N | 0.110 | 10.650 | 53.5 |
| 10.0 N | 0.050 | 10.650 | 22.1 |

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of the Big Eau Pleine Reservoir was quite high at the time the sample was collected.

The yield responses to the orthophosphorus spikes were somewhat erratic, but the increased yields resulting from the addition of nitrogen alone and in combination with orthophosphorus indicates some nitrogen limitation in the assay sample. The sample N/P ratio was a borderline 13/1.

The mean reservoir data indicate a borderline nitrogen limitation at the time the sample was collected; however, at the same time, the mean N/P ratio at station 1 was 17/1 and at station 2 was 11/1 (i.e., phosphorus limitation would be expected at station 1, and nitrogen limitation would be expected at station 2). The reservoir data also indicate phosphorus limitation at station 1 at the other two sampling times as well, but station 2 is indicated to have been phosphorus limited in June and nitrogen limited again in August.

Survey data do not provide an explanation for these unusual circumstances, but the hydraulics of the reservoir and the proximity of station 2 to Freeman Creek may be involved.

D. Trophic Condition:

Survey data and the reports of others (Schmidt, et al., 1972) show that the Big Eau Pleine Reservoir is eutrophic. Reportedly, rooted aquatic vegetation is essentially non-existent because of

fluctuating water levels, but algal blooms are common. Survey limnologists noted a heavy algal bloom in June, 1972.

Of the 46 Wisconsin lakes studied, 22 had less mean total phosphorus, 37 had less mean inorganic nitrogen, 30 had greater Secchi disc transparency, 35 had less mean chlorophyll *a*, and 36 had less algal assay control yield.

Marked depression of dissolved oxygen was noted at both sampling stations during the August, 1972 sampling.

## V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Wisconsin National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in September, 1972, and was completed in August, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Wisconsin District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S) were determined by using the means of the loads, in lbs/$mi^2$/year, calculated for stations B-1 and C-1 and multiplying the means by the ZZ area in square miles.

The Village of Stratford declined participation in the Survey and nutrient loads from there were estimated at 2.5 lbs P and 7.5 lbs N/capita/year. In the following loading and export tables, the loads attributed to the Big Eau Pleine River do not include the Stratford loads.

The communities of Abbotsford, Colby, and Stetsonville were outside of the 25-mile limit of the Survey, and industries in the drainage basin were excluded because of the constraints of the Survey. However, it

appears these sources may have had an impact on the Big Eau Pleine Reservoir during the sampling year (see discussion, page 2).

A. Waste Sources:

1. Known municipal -

| Name | Pop. Served* | Treatment | Mean Flow (mgd)** | Receiving Water |
|---|---|---|---|---|
| Stratford | 1,279 | Act. sludge | 0.128 | Big Eau Pleine River |
| Colby | 1,178 | trickling filter | 0.118 | Dill Creek |
| Abbotsford | 1,375 | trickling | 0.138 | Porky Creek |
| Stetsonville | 305 | Seepage lagoon | 0.030 | (no discharge) |

2. Industrial -

Reportedly (McKersie, et al., 1970), in the Big Eau Pleine drainage basin there are nine cheese plants, a whey-drying plant, a milk-processing plant, a rendering plant, and a mink farm, all having individual waste treatment facilities. When last surveyed by the Wisconsin Department of Natural Resources in 1969-70, the waste treatment of three of the cheese plants was considered unsatisfactory. However, the treatment facilities and/or practices were improved and are adequate at this time (Schraufnagel, 1974).

* 1970 Census.
** Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

| Source | lbs P/ yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| Big Eau Pleine River | 77,760 | 84.9 |
| Fenwood Creek | 5,020 | 5.4 |
| Freeman Creek | 1,450 | 1.6 |
| b. Minor tributaries & immediate drainage (non-point load) - | 3,900 | 4.2 |
| c. Knwon municipal - | | |
| Stratford | 3,200 | 2.7 |
| Colby | ? | - |
| Abbotsford | ? | - |
| Stetsonville | (no discharge) | - |
| d. Septic tanks* - | 60 | <0.1 |
| e. Industrial - | ? | - |
| f. Direct precipitation** - | 1,070 | 1.2 |
| Total | 92,460 | 100.0 |

2. Outputs -

Lake outlet 69,080

3. Net annual P accumulation - 23,380 pounds.

* Estimated 100 dwellings on lakeshore; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

| Source | lbs N/ yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| Big Eau Pleine River | 968,350 | 72.7 |
| Fenwood Creek | 91,280 | 6.8 |
| Freeman Creek | 83,130 | 6.2 |
| b. Minor tributaries & immediate drainage (non-point load) - | 114,320 | 8.6 |
| c. Known municipal - | | |
| Stratford | 9,590 | 0.6 |
| Colby | ? | - |
| Abbotsford | ? | - |
| Stetsonville | (No discharge) | - |
| d. Septic tanks* - | 2,350 | 0.2 |
| e. Industrial - | ? | - |
| f. Direct precipitation** - | 65,810 | 4.9 |
| Total | 1,334,830 | 100.0 |

2. Outputs -

| | |
|---|---|
| Lake outlet | 1,455,230 |

3. Net annual N loss - 120,400 pounds.

* Estimated 100 dwellings on lakeshore; see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Sub-drainage area:

| Tributary | lbs P/mi$^2$/yr | lbs N/mi$^2$/yr |
|---|---|---|
| Big Eau Pleine River | 314 | 3,882 |
| Fenwood Creek | 136 | 2,467 |
| Freeman Creek | 55 | 3,137 |

E. Yearly Loading Rates:

| | Total Phosphorus | | Total Nitrogen | |
|---|---|---|---|---|
| Units | Total | Accumulated | Total | Accumulated |
| lbs/acre/yr | 13.5 | 3.4 | 195.4 | loss* |
| grams/m$^2$/yr | 1.52 | 0.38 | 21.9 | - |

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Big Eau Pleine Reservoir:

| | |
|---|---|
| "Dangerous" (eutrophic rate) | 0.64 |
| "Permissible" (oligotrophic rate) | 0.32 |

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the Reservoir, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, or (probably) the seasonal drawdown of the Reservoir for power production at downstream Lake DuBoy.

## VI. LITERATURE REVIEWED

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TRIBUTARY FLOW INFORMATION FOR WISCONSIN 9/30/74

LAKE CODE 5565 BIG EAU PLEINE RESERVOIR

TOTAL DRAINAGE AREA OF LAKE, 365.00

| TRIBUTARY | SUB-DRAINAGE AREA | NORMALIZED FLOWS JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 556SA1 | 365.00 | 35.50 | 35.50 | 947.70 | 1137.20 | 414.60 | 414.60 | 153.90 | 99.50 | 390.90 | 165.80 | 189.50 | 103.10 | 341.05 |
| 556SA2 | 250.00 | 21.00 | 18.00 | 520.00 | 640.00 | 240.00 | 240.00 | 930.00 | 66.00 | 210.00 | 92.00 | 110.00 | 55.00 | 263.42 |
| 556SB1 | 37.00 | 3.40 | 1.60 | 53.00 | 82.00 | 38.00 | 38.00 | 15.00 | 10.00 | 23.00 | 12.00 | 15.00 | 5.10 | 24.70 |
| 556SC1 | 26.50 | 2.40 | 1.10 | 36.00 | 57.00 | 28.00 | 28.00 | 11.00 | 7.60 | 16.00 | 8.30 | 10.00 | 3.40 | 17.42 |
| 556SZ2 | 51.50 | 4.60 | 2.50 | 79.00 | 120.00 | 53.00 | 53.00 | 21.00 | 14.00 | 34.00 | 17.00 | 20.00 | 7.80 | 35.53 |

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 365.00
SUM OF SUB-DRAINAGE AREAS = 365.00
TOTAL FLOW IN = 4072.80
TOTAL FLOW OUT = 4087.80

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 556SA1 | 9 | 72 | 820.00 | 23 | 210.00 | 24 | 230.00 | | |
| | 10 | 72 | 340.00 | 14 | 250.00 | 15 | 250.00 | | |
| | 11 | 72 | 460.00 | 12 | 330.00 | 15 | 0.0 | | |
| | 12 | 72 | 360.00 | 10 | 200.00 | | | | |
| | 1 | 73 | 390.00 | 7 | 410.00 | 21 | 84.00 | | |
| | 2 | 73 | 1000.00 | 11 | 1000.00 | | | | |
| | 3 | 73 | 1100.00 | 4 | 850.00 | 11 | 0.0 | | |
| | 4 | 73 | 1200.00 | 7 | 1000.00 | 8 | 740.00 | 18 | 2900.00 |
| | 5 | 73 | 1500.00 | 6 | 990.00 | 23 | 0.0 | 26 | 6800.00 |
| | 6 | 73 | 250.00 | 7 | 490.00 | 21 | 230.00 | | |
| | 7 | 73 | 480.00 | 15 | 700.00 | 28 | 480.00 | | |
| | 8 | 73 | 350.00 | 19 | 160.00 | 24 | 120.00 | | |
| 556SA2 | 9 | 72 | 640.00 | 23 | 46.00 | 24 | 34.90 | | |
| | 10 | 72 | 340.00 | 14 | 110.00 | 15 | 82.00 | | |
| | 11 | 72 | 340.00 | 12 | 180.00 | 15 | 40.00 | | |
| | 12 | 72 | 34.00 | 10 | 30.00 | | | | |
| | 1 | 73 | 160.00 | 7 | 140.00 | 21 | 280.00 | | |
| | 2 | 73 | 48.00 | 11 | 50.00 | | | | |
| | 3 | 73 | 1300.00 | 4 | 240.00 | 11 | 4400.00 | | |
| | 4 | 73 | 880.00 | 7 | 720.00 | 8 | 490.00 | 18 | 820.00 |
| | 5 | 73 | 1200.00 | 6 | 290.00 | 23 | 120.00 | 26 | 2000.00 |
| | 6 | 73 | 68.00 | 7 | 94.00 | 21 | 36.00 | | |
| | 7 | 73 | 11.00 | 15 | 5.20 | 28 | 15.00 | | |
| | 8 | 73 | 17.00 | 19 | 10.00 | 24 | 6.70 | | |

TRIBUTARY FLOW INFORMATION FOR WISCONSIN 9/30/74

LAKE CODE 5565 BIG EAU PLEINE RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 556581 | 9 | 72 | 68.00 | 23 | 4.90 | 24 | 3.70 | | |
| | 10 | 72 | 43.00 | 14 | 14.00 | 15 | 11.00 | | |
| | 11 | 72 | 43.00 | 12 | 24.00 | 15 | 11.00 | | |
| | 12 | 72 | 3.10 | 10 | 2.70 | | | | |
| | 1 | 73 | 26.00 | 7 | 22.00 | 21 | 46.00 | | |
| | 2 | 73 | 4.40 | 11 | 4.60 | | | | |
| | 3 | 73 | 130.00 | 4 | 24.00 | 11 | 440.00 | | |
| | 4 | 73 | 110.00 | 7 | 90.00 | 8 | 61.00 | 18 | 110.00 |
| | 5 | 73 | 180.00 | 6 | 46.00 | 23 | 20.00 | 26 | 320.00 |
| | 6 | 73 | 10.00 | 7 | 15.00 | 21 | 5.80 | | |
| | 7 | 73 | 1.70 | 15 | 0.90 | 28 | 2.50 | | |
| | 8 | 73 | 2.70 | 19 | 1.60 | 24 | 1.10 | | |
| 5565C1 | 9 | 72 | 46.00 | 23 | 3.40 | 24 | 2.60 | | |
| | 10 | 72 | 30.00 | 14 | 9.80 | 15 | 7.40 | | |
| | 11 | 72 | 30.00 | 12 | 17.00 | 15 | 8.20 | | |
| | 12 | 72 | 2.00 | 10 | 1.80 | | | | |
| | 1 | 73 | 18.00 | 7 | 16.00 | 21 | 33.00 | | |
| | 2 | 73 | 3.90 | 11 | 3.10 | | | | |
| | 3 | 73 | 88.00 | 4 | 16.00 | 11 | 290.00 | | |
| | 4 | 73 | 76.00 | 7 | 62.00 | 8 | 42.00 | 18 | 76.00 |
| | 5 | 73 | 130.00 | 6 | 33.00 | 23 | 14.00 | 26 | 230.00 |
| | 6 | 73 | 7.70 | 7 | 11.00 | 21 | 4.20 | | |
| | 7 | 73 | 1.20 | 15 | 0.70 | 28 | 1.80 | | |
| | 8 | 73 | 1.90 | 19 | 1.20 | 24 | 0.80 | | |
| 5565ZZ | 9 | 72 | 100.00 | 23 | 7.30 | 24 | 5.60 | | |
| | 10 | 72 | 61.00 | 14 | 20.00 | 15 | 15.00 | | |
| | 11 | 72 | 62.00 | 12 | 35.00 | 15 | 16.00 | | |
| | 12 | 72 | 4.80 | 10 | 4.10 | | | | |
| | 1 | 73 | 35.00 | 7 | 31.00 | 21 | 64.00 | | |
| | 2 | 73 | 6.80 | 11 | 6.90 | | | | |
| | 3 | 73 | 200.00 | 4 | 36.00 | 11 | 660.00 | | |
| | 4 | 73 | 160.00 | 7 | 130.00 | 8 | 87.00 | 18 | 160.00 |
| | 5 | 73 | 250.00 | 6 | 64.00 | 23 | 27.00 | 26 | 440.00 |
| | 6 | 73 | 15.00 | 7 | 21.00 | 21 | 7.80 | | |
| | 7 | 73 | 2.40 | 15 | 1.20 | 28 | 3.40 | | |
| | 8 | 73 | 3.70 | 19 | 2.20 | 24 | 1.50 | | |

# APPENDIX B

## PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

556501
44 44 00.0 089 46 12.0
BIG EAU PLEINE RESERVOIR
55 WISCONSIN

11EPALES
3

2111202
0025 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/06/23 | 14 20 | 0000 | 19.0 | 10.1 | 36 | 80 | 8.70 | 20 | 0.580 | 0.050 | 0.045 | 0.021 |
| | 14 20 | 0020 | 19.0 | 9.4 | | 75 | 8.50 | 19 | 0.570 | 0.060 | 0.078 | 0.030 |
| 72/08/24 | 13 00 | 0000 | | | 33 | 90 | 7.40 | 33 | 0.060 | 0.160 | 0.049 | 0.017 |
| | 13 00 | 0004 | 19.9 | 6.6 | | 89 | 7.50 | 34 | 0.070 | 0.170 | 0.055 | 0.015 |
| | 13 00 | 0010 | 19.9 | 6.6 | | 89 | 7.50 | 35 | 0.060 | 0.160 | 0.056 | 0.018 |
| | 13 00 | 0015 | 19.8 | 6.4 | | 89 | 7.60 | 35 | 0.060 | 0.180 | 0.058 | 0.019 |
| | 13 00 | 0020 | 19.8 | 0.8 | | 98 | 6.70 | 35 | 0.070 | 0.550 | 0.057 | 0.028 |
| 72/11/08 | 10 40 | 0000 | | | 24 | 100 | 7.30 | 16 | 0.440 | 0.140 | 0.076 | 0.038 |
| | 10 40 | 0004 | 5.2 | 11.6 | | 95 | 7.30 | 16 | 0.440 | 0.130 | 0.082 | 0.035 |
| | 10 40 | 0015 | 5.2 | 11.5 | | 95 | 7.30 | 17 | 0.460 | 0.150 | 0.071 | 0.034 |
| | 10 40 | 0022 | 5.2 | 11.3 | | 95 | 7.30 | 16 | 0.440 | 0.140 | 0.068 | 0.034 |
| | 10 40 | 0029 | 5.2 | 11.6 | | 95 | 7.30 | 17 | 0.440 | 0.130 | 0.077 | 0.032 |
| | 10 40 | 0036 | 5.2 | 11.2 | | 95 | 7.30 | 19 | 0.440 | 0.120 | 0.071 | 0.030 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/06/23 | 14 20 | 0000 | 70.3J |
| 72/08/24 | 13 00 | 0000 | 26.6J |
| 72/11/08 | 10 40 | 0000 | 48.9J |

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

556502
44 44 24.0 089 51 24.0
BIG EAU PLEINE RESERVOIR
55 WISCONSIN

11EPALES
3

2111802
0015 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/06/23 | 14 45 | 0000 | 20.0 | 10.1 | 36 | 90 | 8.60 | 22 | 0.350 | 0.030 | | 0.026 |
| | 14 45 | 0010 | 19.8 | 10.0 | | 90 | 8.60 | 22 | 0.350 | 0.040 | 0.139 | 0.026 |
| 72/08/24 | 13 25 | 0000 | | | 41 | 100 | 7.10 | 25 | 0.080 | 0.250 | 0.060 | 0.029 |
| | 13 25 | 0004 | 20.4 | | | 99 | 7.30 | 25 | 0.080 | 0.270 | 0.062 | 0.028 |
| | 13 25 | 0015 | 20.3 | 5.0 | | 100 | 7.80 | 26 | 0.060 | 0.300 | 0.065 | 0.033 |
| | 13 25 | 0020 | 19.8 | 2.4 | | 108 | 6.90 | 29 | 0.060 | 0.490 | 0.089 | 0.049 |
| 72/11/08 | 11 15 | 0000 | | | 22 | 130 | 7.20 | 23 | 0.620 | 0.180 | 0.107 | 0.047 |
| | 11 15 | 0004 | 4.8 | 11.0 | | 120 | 7.20 | 23 | 0.600 | 0.180 | 0.102 | 0.071 |
| | 11 15 | 0014 | 4.8 | 11.0 | | 120 | 7.20 | 25 | 0.600 | 0.160 | 0.083 | 0.060 |
| | 11 15 | 0019 | 4.8 | 10.9 | | 120 | 7.20 | 22 | 0.590 | 0.160 | 0.106 | 0.060 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/06/23 | 14 45 | 0000 | 39.9J |
| 72/08/24 | 13 25 | 0000 | 8.8J |
| 72/11/08 | 11 15 | 0000 | 18.3J |

J VALUE KNOWN TO BE IN ERROR

# APPENDIX C

# TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/02

S5565A1 L5556SA1
44 04 00.0 089 45 30.0
SIG EAU PLEINE RIVER
55 15 MILLADORE
O/-IG EAU PLEINE RES
AT RES FLOOD GATE .5 NW OF DANCY
WIPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO3&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/03/24 | 09 | 12 | 0.100 | 2.600 | 0.252 | 0.011 | 0.035 |
| 72/10/14 | 15 | 45 | 0.270 | 2.650 | 0.220 | 0.027 | 0.115 |
| 72/11/13 | 13 | 35 | 0.320 | 1.100 | 0.060 | 0.024 | 0.046 |
| 72/12/10 | 13 | 10 | 0.420 | 1.150 | 0.039 | 0.022 | 0.050 |
| 73/01/21 | 10 | 30 | 0.520 | 1.000 | 0.220 | 0.042 | 0.080 |
| 73/02/11 | 10 | 55 | 0.630 | 1.050 | 0.168 | 0.044 | 0.090 |
| 73/03/04 | 13 | 50 | 0.830 | 1.100 | 0.251 | 0.046 | 0.097 |
| 73/04/07 | 11 | 10 | 0.440 | 1.470 | 0.590 | 0.110 | 0.170 |
| 73/04/19 | 17 | 10 | 0.304 | 2.800 | 0.220 | 0.042 | 0.095 |
| 73/05/06 | 13 | 35 | 0.390 | 1.900 | 0.090 | 0.023 | 0.085 |
| 73/05/30 | 10 | 00 | 0.360 | 3.500 | 0.210 | 0.021 | 0.085 |
| 73/06/07 | 10 | 50 | 0.320 | 1.600 | 0.200 | 0.027 | 0.070 |
| 73/07/28 | 15 | 15 | 0.048 | 1.540 | 0.160 | 0.024 | 0.117 |
| 73/09/24 | 15 | 45 | 0.050 | 1.890 | 0.240 | | 0.150 |

STORET RETRIEVAL DATE 74/10/22

5565A2 LS5565A2
44 48 00.0 090 01 00.0
BIG E AU PLEINE RIVER
55 15 STRATFORD
1/BIG EAU PLEINE RES
BRDG AT BRADLEY BELO STRATFORD STP
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/23 | 15 30 | | 0.260 | 2.100 | 0.140 | 0.200 | 0.320 |
| 72/10/15 | 14 50 | | 0.410 | 1.100 | 0.073 | 0.110 | 0.180 |
| 72/11/15 | 14 50 | | 0.720 | 0.760 | 0.056 | 0.078 | 0.115 |
| 72/12/10 | 14 23 | | 0.480 | 2.000 | 0.176 | 0.060 | 0.140 |
| 73/01/07 | 14 40 | | 0.940 | 2.520 | 0.290 | 0.099 | 0.168 |
| 73/02/11 | 15 20 | | 1.220 | 1.700 | 0.126 | 0.138 | 0.170 |
| 73/03/11 | 13 52 | | 0.410 | 2.200 | 0.670 | 0.231 | 0.400 |
| 73/04/09 | 14 50 | | 0.360 | 1.200 | 0.029 | 0.054 | 0.085 |
| 73/04/21 | 09 50 | | 0.460 | 0.220 | 0.048 | 0.052 | 0.075 |
| 73/05/06 | 14 00 | | 0.440 | 0.840 | 0.050 | 0.056 | 0.090 |
| 73/05/23 | 10 45 | | 0.056 | 2.360 | 0.150 | 0.045 | 0.100 |
| 73/06/21 | 12 25 | | 0.198 | 1.300 | 0.014 | | 0.240 |
| 73/07/15 | 11 10 | | 0.010K | 2.100 | 0.138 | 0.054 | 0.155 |
| 73/09/19 | 09 15 | | 0.010K | 0.690 | 0.052 | 0.086 | 0.165 |

K VALUE KNOWN TO BE LESS THAN INDICATED

25

STORET RETRIEVAL DATE 74/10/02

5565A3 LS5565A3
44 49 30.0 090 05 00.0
BIG EAU PLEINE RIVER
55 15 STRATFORD
1/BIG EAU PLEINE RES
ST HWY 97 BRDG ABV STRATFORD STP
11EPALES
4 2111204
0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/23 | 15 00 | | 0.221 | 1.950 | 0.160 | 0.189 | 0.300 |
| 72/11/15 | 10 55 | | 0.590 | 0.750 | 0.020 | 0.078 | 0.110 |
| 72/12/10 | 14 46 | | 0.460 | 2.000 | 0.160 | 0.066 | 0.138 |
| 73/01/07 | 08 05 | | 0.930 | 2.400 | 0.290 | 0.100 | 0.170 |
| 73/02/11 | 14 30 | | 1.240 | 1.760 | 0.140 | 0.140 | 0.170 |
| 73/03/11 | 14 28 | | 0.410 | 2.300 | 0.685 | 0.240 | 0.405 |
| 73/04/08 | 15 12 | | 0.360 | 1.050 | 0.028 | 0.055 | 0.095 |
| 73/04/21 | 09 30 | | 0.350 | 0.660 | 0.023 | 0.050 | 0.095 |
| 73/05/06 | 13 00 | | 0.315 | 0.720 | 0.031 | 0.052 | 0.085 |
| 73/05/23 | 10 30 | | 0.025 | 3.000 | 0.154 | 0.060 | 0.115 |
| 73/06/21 | 12 10 | | 0.105 | 3.400 | 0.230 | 0.011 | 0.220 |
| 73/07/15 | 11 25 | | 0.010K | 1.700 | 0.050 | 0.048 | 0.150 |
| 73/09/19 | 09 20 | | 0.021 | 0.560 | 0.034 | 0.042 | 0.140 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/02

5565B1 LS5565B1
44 48 00.0 089 58 30.0
FENWOOD CREEK
55 15 MARATHON
T/BIG FAU PLEINE RES
ST HWY 153 BROG 4.75 MI E OF STRATFORD
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/23 | 00 45 | | 0.195 | 1.500 | 0.154 | 0.066 | 0.147 |
| 72/10/15 | 15 20 | | 0.540 | 0.750 | 0.060 | 0.018 | 0.044 |
| 72/11/15 | 11 30 | | 1.860 | 0.460 | 0.017 | 0.021 | 0.035 |
| 73/03/11 | 13 26 | | 0.400 | 2.150 | 0.660 | 0.240 | 0.410 |
| 73/04/08 | 14 18 | | 0.440 | 0.800 | 0.040 | 0.014 | 0.060 |
| 73/04/21 | 10 15 | | 0.990 | 0.630 | 0.030 | 0.018 | 0.050 |
| 73/05/06 | 14 05 | | 1.180 | 0.500 | 0.024 | 0.019 | 0.030 |
| 73/05/23 | 11 00 | | 0.310 | 3.100 | 0.200 | 0.028 | 0.050 |
| 73/06/21 | 12 40 | | 0.260 | 1.980 | 0.189 | 0.017 | 0.030 |
| 73/07/15 | 10 55 | | 0.010K | 1.800 | 0.046 | 0.046 | 0.145 |
| 73/08/19 | 09 45 | | 0.058 | 0.615 | 0.038 | 0.042 | 0.123 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/02

5565C1 LS5565C1
44 47 00.0 089 51 30.0
FREEMAN CREEK
55 15 MARATHON
T/BIG EAU PLEINE RES
SUGAR BUSH RD 1 MI SSE OF HALDER
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/24 | 08 45 | | 0.580 | 0.950 | 0.096 | 0.038 | 0.071 |
| 72/10/14 | 15 25 | | 0.980 | 1.000 | 0.090 | 0.014 | 0.032 |
| 72/11/12 | 13 05 | | 1.640 | 0.800 | 0.020 | 0.020 | 0.040 |
| 72/12/10 | 12 20 | | 2.040 | 0.520 | 0.021 | 0.015 | 0.020 |
| 73/01/21 | 10 30 | | 1.540 | 0.840 | 0.231 | 0.036 | 0.080 |
| 73/02/11 | 10 35 | | 2.003 | 0.140 | 0.050 | 0.016 | 0.020 |
| 73/03/04 | 13 25 | | 1.560 | 1.750 | 1.600 | 0.240 | 0.340 |
| 73/04/07 | 10 45 | | 0.690 | 1.050 | 0.056 | 0.015 | 0.045 |
| 73/04/18 | 17 35 | | 1.520 | 1.400 | 0.066 | 0.014 | 0.045 |
| 73/05/04 | 14 00 | | 1.300 | 1.700 | 0.085 | 0.015 | 0.020 |
| 73/05/26 | 09 45 | | 0.310 | 2.800 | 0.105 | 0.023 | 0.065 |
| 73/06/07 | 10 30 | | 0.740 | | 0.070 | 0.013 | 0.040 |
| 73/07/28 | 14 45 | | 0.720 | 0.700 | 0.038 | 0.028 | 0.060 |
| 73/08/24 | 14 30 | | 0.740 | 0.600 | 0.037 | 0.017 | 0.040 |

28A